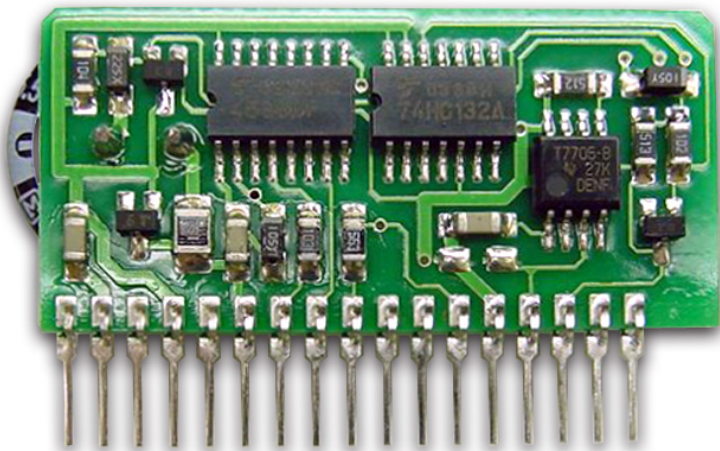


# UNIT 1

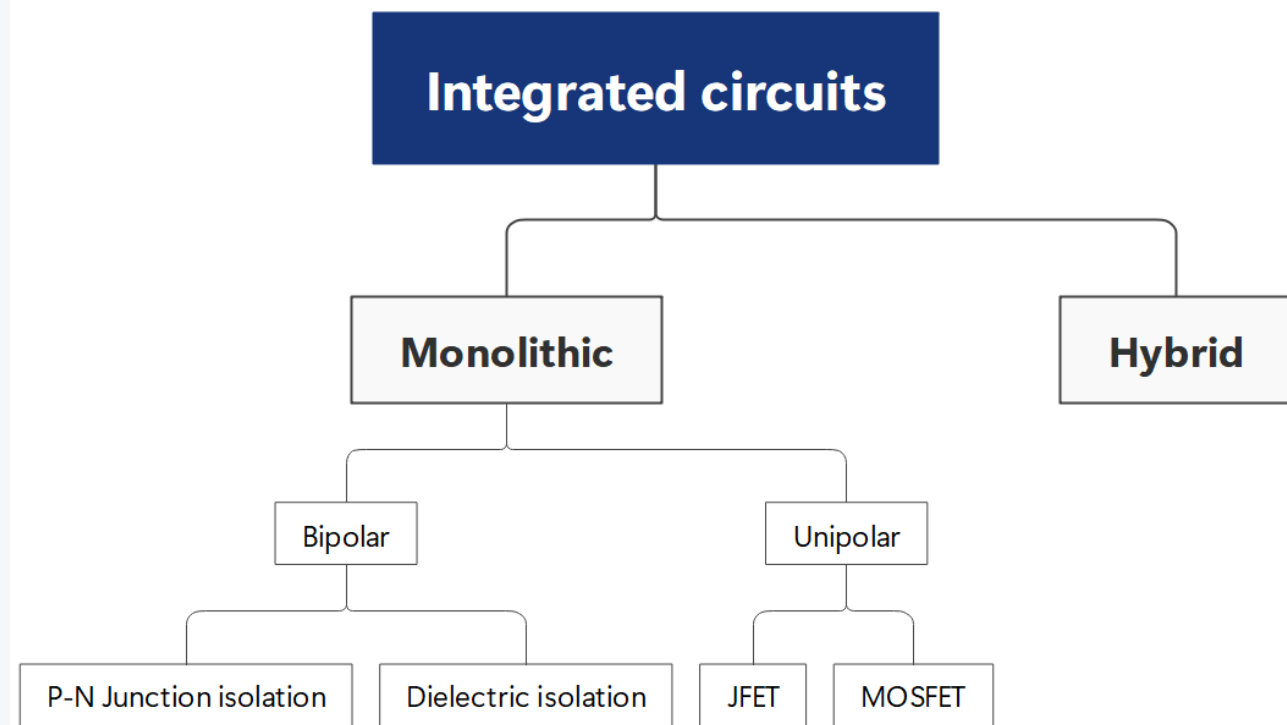
## Advantages of IC over discrete components.

- Reduced cost due to batch processing.
- Increased component density due to miniaturization. P
- Increased operating speed due to reduced parasitic capacitance effect.
- Matched devices.
- Increased reliability due to absence of soldering joints.
- Reduced power consumption.

## Hybrid vs Monolithic

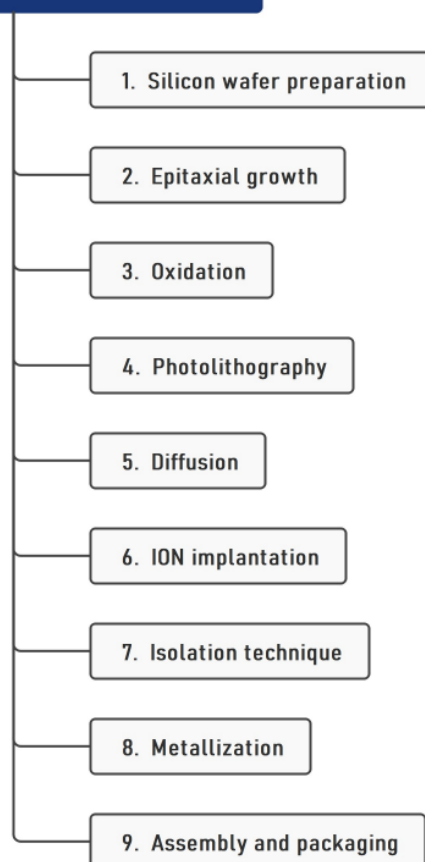
| Hybrid                                                                             | Monolithic                                                                            |
|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  |  |
| Contains 2 or more silicon chip mounted on ceramic substrate.                      | Fabricated only one silicon chip                                                      |
| Cheaper                                                                            | Costly                                                                                |
| Flexible in circuit design                                                         | Not that much flexible                                                                |
| Slower operating speed                                                             | Fast operating speed                                                                  |
| Large in size                                                                      | Small in size                                                                         |

## Classification of IC



What are the basic processes involved in fabricating ICs using planar technology?

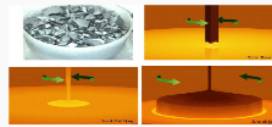
### Planar technology of fabricating IC



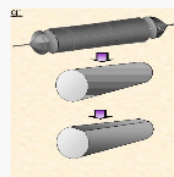
List out the steps used in the preparation of Si wafers.

### Steps for silicon wafer preparation

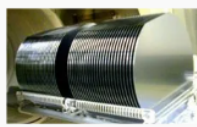
1. Crystal growth and doping



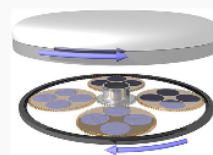
2. Ingot trimming and grinding



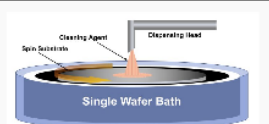
3. Ingot slicing



4. Wafer polishing and etching



5. Wafer Cleaning



What is dielectric isolation?

- A layer of dielectric (usually  $SiO_2$  or ruby) is used to provide electrical and physical isolation from other components of IC.
- With this isolation there is negligible parasitic capacitance.
- Expensive to manufacture.

What are the two important properties of  $SiO_2$ ?

- Excellent insulator.
- Very stable.
- It can be easily deposited and grown thermally on silicon wafers.

What are the different types of lithography?

#### Types of lithography

- Electron beam lithography.
- X-ray lithography.

#### What is optical lithography?

Etching (removing) IC with light is called photo lithography or optical lithography.

#### Distinguish between dry etching and wet etching.

| Dry etching                                        | Wet etching                                 |
|----------------------------------------------------|---------------------------------------------|
| Chemical reagents are used in gaseous form .       | Chemical reagents used are in liquid form.  |
| More accurate and small size can be achieved       | Less accurate                               |
| Expensive because specialized equipment is needed. | Cheap because only chemical bath is needed. |

#### What are the advantages of ion implantation technique?

- Done at lower temperature so there is lesser tendency of lateral spreading.
- Depth and Dose of impurity can be carefully controlled by changing the voltage.

#### What is metallization?

Deposition of metal film on IC to make electrical inter-connection between the components and outside world.

- Usually Al is used since it is a very **good conductor**.
- Makes good mechanical bond with silicon.
- **Easy** to deposit using vacuum deposition and it makes good bond with Si.
- Forms ohmic or non rectifying contact with P-type silicon and heavily doped N-type.

### Define diffusion

The process of adding impurity to Si wafer is diffusion. It is carried out in high temperature.

Differentiate the ideal and practical characteristics of an op-amp.

| Ideal                    | Practical                                               |
|--------------------------|---------------------------------------------------------|
| Infinite input impedance | Very high input impedance                               |
| Infinite voltage gain    | Very high voltage gain in the order of $10^5$ or $10^8$ |
| Zero output impedance    | Very Less output impedance                              |
| Infinite bandwidth       | Wide bandwidth                                          |
| Infinite slew rate       | Very high slew rate                                     |
| Infinite CMRR            | Very high CMRR                                          |

Define input bias current of an operational amplifier.

It is the average of the 2 DC currents flowing into the input terminals of OP amp.

$$I_B = \frac{I_B^+ + I_B^-}{2}$$

What are the causes of slew rate?

It is caused usually by capacitance inside or outside the op-amp. This capacitance is which prevents the output respond to input instantly.

Define input offset current of an operational amplifier.

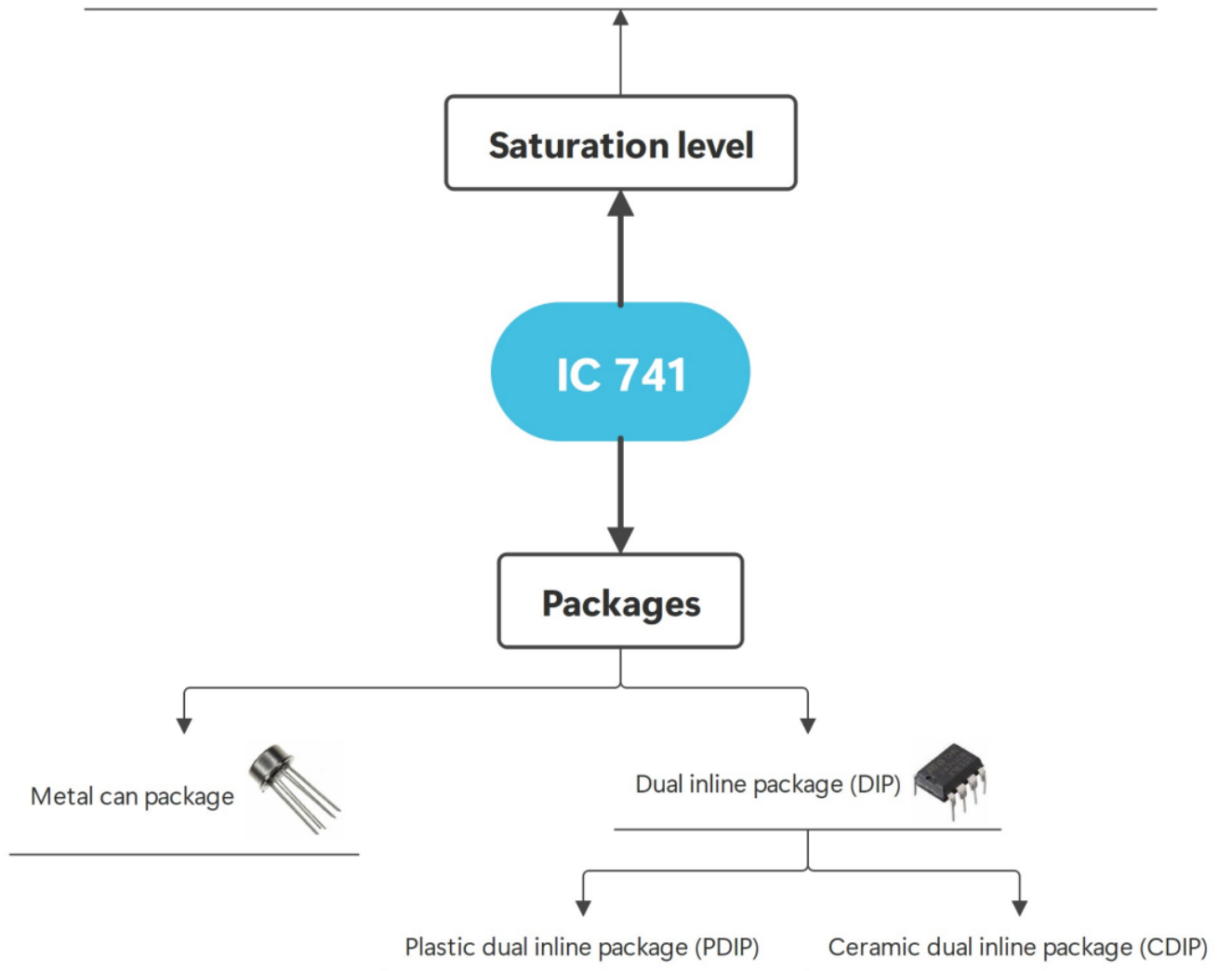
It is difference between current flowing into input terminals.

$$I_{OS} = I_B^+ - I_B^-$$

Write the saturation level of an IC 741. Mention different available IC package configurations.

*$\pm 10$  is typical saturation voltage for  $\pm 12$  Volt supply*

---



State the types of compensation used in an op-amp.

Draw the frequency response of an op-amp.

Define input offset voltage.

It is **voltage that needs to be applied** in input terminal to get Zero output voltage.

Define CMRR of an op-amp.

It is the ability of an Op-amp to reject common mode signal.

$$CMRR = \left| \frac{A_d}{A_c} \right|$$

Define thermal drift.

Change in ==Bias voltage, Bias current , Offset current == with temperature is called thermal drift.

---

How is the gain stabilized by negative feedback?

---

What is an inverting amplifier?

A circuit that amplifies with inverting the output is called Non-inverting amplifier.

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What is a Non inverting amplifier?

A circuit that amplifies without inverting the output is called Non-inverting amplifier.

---

How an op-amp can be used as a voltage follower?

---

What is a summer?

---

What is differential amplifier?

A circuit which amplifies the difference b/w two signals is called differential amplifier.

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List the applications of V-I converter?

---

List the applications of I-V converter?

---

Draw the circuit diagram of V-I converter?

---

Draw the circuit diagram of I-V converter?

---

Design an adder circuit using an op-amp to get the output expression as

$$V_o = -(V_1 + 0.1V_2 + 20V_3) \text{ where } V_1, V_2, V_3 \text{ are the inputs.}$$

---

Design an adder circuit using an op-amp to get the output expression as  $V_o = -(0.2V_1 + 3V_2 + 5V_3)$  where  $V_1, V_2, V_3$  are the inputs.

---

#### Disadvantage of ICs

- If one component fails entire IC has to be replaced.
- Transformer and inductor are impossible to fabricate.
- Parameters and components of IC cannot be changed, Hence not flexible.